DESCRIPTION

RADIO BASE STATION APPARATUS, RADIO NETWORK CONTROL
APPARATUS AND TRANSFER RATE DETERMINING METHOD

Technical Field

The present invention relates to a radio base station
apparatus, etc., in a mobile communication system in which
a so-called best effort type transmission scheme is
applied to a communication between a mobile terminal
apparatus and radio base station apparatus.

Background Art

Various studies are being currently conducted on
the application of an HSDPA (High Speed Downlink Packet
Access) technology to data transmission between a mobile
terminal apparatus and radio base station apparatus in
a mobile communication system. The HSDPA is a technology,
standardization of which the 3GPP (3rd Generation
Partnership Project) is fostering (e.g., see 3GPP,
TS25.401 UTRAN overall description, V3.10.0 and 3GPP,
TR25.858 Physical layer aspects of UTRA High Speed
Downlink Packet Access, V5.0.0). The HSDPA realizes
speed enhancement of a downlink from a radio base station
apparatus to a mobile terminal apparatus by applying to
a wireless channel, adaptive modulation, H-ARQ (Hybrid
Automatic Repeat reQuest), high-speed selection of a
mobile terminal apparatus at the communication

destination and adaptive control of transmission
parameters, etc., according to a situation of the wireless
channel.

The HSDPA is a transmission scheme whereby one
5   wireless channel is shared by a plurality of mobile
terminal apparatuses, and therefore the HSDPA provides
a best effort type communication. In the HSDPA, a
plurality of mobile terminal apparatuses report the
channel condition of their downlink channels to the radio
10 base station apparatus and the radio base station
apparatus schedules the order in which data is transmitted
to the plurality of mobile terminal apparatuses.

In order to realize high-speed data transmission
such as HADPA in a wireless section between a mobile
15 terminal apparatus and radio base station apparatus,
there is a strong demand for a flow control technology
capable of improving data transmission throughput in a
wired section between the radio base station apparatus
and radio network control apparatus. Conventional flow
20 control in the wired section between the radio base station
apparatus and radio network control apparatus will be
explained below.

FIG.1 is a block diagram showing the configuration
of a conventional mobile communication system.

25 The mobile communication system shown in FIG.1 is
constructed of a mobile terminal apparatus 1, a radio
base station apparatus 3, a radio network control
apparatus 5 and a core network 6. The mobile terminal

apparatus 1 and radio base station apparatus 3 are
connected through a wireless channel 2.   On the other hand,
the radio base station apparatus 3 and radio network
control apparatus 5 are connected through a wired channel
5   4.

The radio network control apparatus 5 transfers data
input from the core network 6 to the radio base station
apparatus 3 through the wired channel 4 according to flow
control.   The transferred data is received by a reception
10   section 38 and stored in a buffer 34 temporarily.   This
temporarily stored data is input to a radio transmission
section 31 according to scheduling determined by a
scheduling section 33 according to the channel condition
of a downlink channel, subjected to predetermined radio
15   processing by the radio transmission section 31, and then
sent to the mobile terminal apparatus 1 through the
wireless channel 2.   Furthermore, a transfer parameter
determining section 35 determines a transfer parameter
for flow control based on an amount of data stored in
20   the buffer 34.   The transfer parameter is sent from a
transmission section 37 to the radio network control
apparatus 5 through the wired channel 4.

The transmission section 37 and reception section
38 exist in an FP (Frame Protocol) processing section
25   36 of the radio base station apparatus 3 and carries out
transmission/reception based on an HS-DSCH FP (High Speed
Downlink Shared Channel Frame Protocol).   On the other
hand, the scheduling section 33, buffer 34 and transfer

parameter determining section 35 exist a MAC-hs (Medium
Access Control used for high speed) processing section
32 of the radio base station apparatus 3.

Next, the conventional flow control will be
5 explained. The conventional flow control is carried out
based on the amount of data stored in the buffer 34. That
is, when the transfer parameter determining section 35
sets a threshold for the amount of data stored in the
buffer 34 and the amount of data stored in the buffer
10 34 is not less than the threshold, the transfer parameter
determining section 35 determines a transfer parameter
for instructing the radio network control apparatus 5
to stop the data transfer and then when the amount of
data stored in the buffer 34 falls below the threshold,
15 the transfer parameter determining section 35 determines
a transfer parameter for instructing the radio network
control apparatus 5 to restart the data transfer.

The transfer parameter consists of "credits" which
indicates the amount of data to be transferred through
20 one data transfer process, "interval" which indicates
intervals at which the data transfer process is repeated
and "repetition period" which indicates the number of
times the data transfer process is repeated.

Thus, the radio base station apparatus 3 instructs
25 the radio network control apparatus 5 on a transfer stop
and transfer restart based on the amount of data stored
in the buffer 34, and can thereby prevent data transferred
from the radio network control apparatus from overflowing

the buffer 34 or prevent the buffer 34 from becoming empty, which would interrupt data transmission to the mobile terminal apparatus 1.

Here, since data transmission from the radio base station apparatus 3 to the mobile terminal apparatus 1 through the wireless channel 2 is carried out according to the best effort type HSDPA, the data transmission rate varies with time. Furthermore, the above described conventional flow control always tries to keep the amount of data stored in the buffer 34 of the radio base station apparatus 3 constant regardless of a variation in the transmission rate between the radio base station apparatus 3 and the mobile terminal apparatus 1. Therefore, the time (wait time) during which data is stored in the buffer 34 changes according to the transmission rate between the radio base station apparatus 3 and mobile terminal apparatus 1. For example, when the amount of data stored in the buffer 34 is 64 kbits, the wait time is 1 sec if the transmission rate is 64 kbps, the wait time is 2 sec if the transmission rate is 32 kbps and the wait time is 4 sec if the transmission rate is 16 kbps. That is, the lower the transmission rate between the radio base station apparatus 3 and mobile terminal apparatus 1, the greater the wait time becomes.

Furthermore, when data is discarded due to a transmission error which occurs during transmission between the radio base station apparatus 3 and mobile terminal apparatus 1, data is retransmitted from the radio

network control apparatus 5 according to a retransmission request from the mobile terminal apparatus 1. When the transmission rate between the radio base station apparatus 3 and mobile terminal apparatus 1 is low, the

5   wait time in the buffer 34 increases, and therefore the retransmitted data does not immediately arrive at the mobile terminal apparatus 1. When data does not arrive at the mobile terminal apparatus 1 even if a predetermined time has passed, the radio network control apparatus 5

10   repeats retransmission of the same data. When the retransmission count reaches a predetermined threshold, the radio network control apparatus 5 sends a reset message to the mobile terminal apparatus 1. The mobile terminal apparatus 1 which has received this reset message sends

15   an ACK (ACKnowledgement: positive response) in response to the reset message to the radio network control apparatus 5 and discards all data stored in the own apparatus. Furthermore, the radio network control apparatus 5 which has received the ACK also discards all data stored in

20   the own apparatus. Thus, when all data stored in the mobile terminal apparatus 1 and radio network control apparatus 5 are discarded, their communication is interrupted.

     Furthermore, due to a delay in the buffer 34 of

25   the radio base station apparatus 3, if a reset message sent by the radio network control apparatus 5 does not immediately arrive at the mobile terminal apparatus 1 and as a result, the radio network control apparatus 5

may repeat retransmission of the reset message. In this
case, when the retransmission count of the reset message
reaches a predetermined threshold, the radio network
control apparatus 5 decides that there is some error in

5   the wireless channel 2 and disconnects the wireless
channel 2 used by the mobile terminal apparatus 1. When
the wireless channel 2 is disconnected in this way, the
mobile terminal apparatus 1 can no longer receive the
communication service which has been used so far.

10   The above described problem will be explained more
specifically using a sequence diagram. FIG.2 is an
operation sequence diagram of a conventional mobile
communication system.

         First, the transfer parameter determining section

15   35 of the radio base station apparatus 3 confirms that
the amount of data stored in the buffer 34 is not greater
than the threshold and determines a transfer parameter
for permitting the data transfer. This transfer
parameter is sent from the transmission section 37 to

20   the radio network control apparatus 5.

         The radio network control apparatus 5 starts the
data transfer according to the instruction of the received
transfer parameter. The data 0 to 127 transferred from
the radio network control apparatus 5 are stored in the

25   buffer 34 of the radio base station apparatus 3. Then,
according to scheduling at the scheduling section 33,
the data stored in the buffer 34 are sequentially sent
from the radio transmission section 31 to the mobile

terminal apparatus 1.

At this time, suppose that data 0 is discarded due to a transmission error in the wireless channel 2. When the mobile terminal apparatus 1 receives next data 1,

5   it detects from the discontinuity of the sequence number that data 0 has been discarded during transmission. As a report of the reception condition, the mobile terminal apparatus 1 transmits a retransmission request of data 0 (retransmission request 0) to the radio network control

10   apparatus 5. At the same time, the mobile terminal apparatus 1 starts a timer for controlling intervals of reporting of the reception condition. When the radio network control apparatus 5 receives the retransmission request 0, it retransmits data 0.

15   The retransmitted data 0 is stored in the buffer 34 of the radio base station apparatus 3. However, since all the previously stored data have not been transmitted yet, retransmitted data 0 is not immediately transmitted to the mobile terminal apparatus 1. Until the

20   retransmitted data 0 is sent to the mobile terminal apparatus 1, the radio base station apparatus 3 sends other data stored in the buffer 34 (data 2 to 127) to the mobile terminal apparatus 1 sequentially. That is, the retransmitted data 0 remains stored in the buffer

25   34 until data 127 is sent. As a result, as shown in FIG.2, the wait time of data 0 in the buffer 34 becomes enormous.

Moreover, the mobile terminal apparatus 1 has not received data 0 whose retransmission is requested yet

even when the timer times out, and therefore the mobile

terminal apparatus 1 sends a retransmission request 0

to the radio network control apparatus 5 again. Every

time the radio network control apparatus 5 retransmits

5   the same data (data 0), it counts up a transmission count

(D) and when this value reaches a predetermined number

of times (4 in the example of FIG.2), the radio network

control apparatus 5 sends a reset message to the mobile

terminal apparatus 1. As described above, this causes

10   all the data stored in the radio network control apparatus

5 and mobile terminal apparatus 1 to be discarded.

Furthermore, when the reset message sent from the

radio network control apparatus 5 does not immediately

arrive at the mobile terminal apparatus 1 due to a delay

15   in the buffer 34, the radio network control apparatus

5 retransmits a reset message every time the timer times

out. Every time the radio network control apparatus 5

transmits a reset message, it counts up a transmission

count (R) and when this value reaches a predetermined

20   number of times (3 in the example of FIG.2), the radio

network control apparatus 5 decides it as an error of

the wireless channel 2 and disconnects the wireless

channel 2 used by the mobile terminal apparatus 1.

Thus, the conventional flow control based on only

25   a wait time in the buffer can be hardly attuned to a

communication system (e.g., the above described HSDPA)

in which best effort type transmission is carried out

through a wireless channel between the radio base station

apparatus and mobile terminal apparatus.

Disclosure of Invention

It is an object of the present invention to provide
a radio base station apparatus, etc., in a communication
system in which best effort type transmission is carried
out through a wireless channel between the radio base
station apparatus and a mobile terminal apparatus,
capable of reducing a wait time in a buffer.

According to an aspect of the present invention,
the radio base station apparatus comprises a determining
section that determines a transfer rate of data
transferred from a radio network control apparatus, a
storage section that temporarily stores data transferred
from the radio network control apparatus at the transfer
rate, a transmission section that transmits the data
stored in the storage section to a mobile terminal
apparatus by radio, a wait time measuring section that
measures a wait time of the data in the storage section
and a transmission rate calculation section that
calculates an average transmission rate of data
transmitted to the mobile terminal apparatus by radio,
wherein the determining section uses a value obtained
by multiplying the average transmission rate by a
coefficient according to the wait time as the transfer
rate.

The radio base station apparatus preferably further
comprises a data amount measuring section that measures

the amount of data stored in the storage section, wherein the wait time measuring section regards a value obtained by dividing the amount of data measured by the data amount measuring section by the average transmission rate

5   calculated by the transmission rate calculation section as the wait time.

The radio base station apparatus preferably further comprises a data amount measuring section that measures an amount of data stored in the storage section, wherein

10   the transmission rate calculation section calculates an actual average transmission rate when the amount of data measured by the data amount measuring section is equal to or greater than a threshold and calculates a virtual average transmission rate when the amount of data measured

15   by the data amount measuring section is less than the threshold.

The radio base station apparatus preferably further comprises an adding section that adds time information to data when the data is input to the storage section,

20   wherein the wait time measuring section measures the wait time from the time indicated by the time information and the time at which the data is output from the storage section.

According to another aspect of the present invention,

25   a radio network control apparatus comprises a transfer section that transfers data to the radio base station apparatus at a transfer rate determined by the radio base station apparatus and a control section that performs

retransmission control of data based on a selective retransmission type retransmission control protocol, wherein the transfer section notifies the control section of the transfer rate so as to match the transfer rate at the transfer section to the transfer rate at the control section.

According to a further aspect of the present invention, the transfer rate determining method is a transfer rate determining method used at a radio base station apparatus, comprising the steps of determining a transfer rate of data transferred from a radio network control apparatus, temporarily storing data transferred from the radio network control apparatus at the transfer rate in a buffer and sending the data stored in the buffer to a mobile terminal apparatus by radio, wherein a value obtained by multiplying an average transmission rate of data sent to the mobile terminal apparatus by radio by a coefficient according to a wait time of data in the buffer is regarded as a transfer rate of the data transferred from the radio network control apparatus.

The transfer rate determining method preferably sets the transfer rate of data transferred from the radio network control apparatus to 0 to stop the data transfer when the amount of data stored in the buffer is equal to or greater than a threshold.

Brief Description of Drawings

FIG.1 is a block diagram showing the configuration of a conventional mobile communication system;

FIG.2 is an operation sequence diagram of the conventional mobile communication system;

5   FIG.3 is a block diagram showing the configuration of a mobile communication system according to an embodiment of the present invention;

FIG.4 is a table stored in the radio base station apparatus according to the embodiment of the present

10   invention;

FIG.5 is a block diagram showing the configuration of another radio base station apparatus according to the embodiment of the present invention;

FIG.6 is a block diagram showing the configuration

15   of the radio network control apparatus according to the embodiment of the present invention; and

FIG.7 is an operation sequence diagram of the mobile communication system according to the embodiment of the present invention.

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Best Mode for Carrying out the Invention

With reference now to the attached drawings, an embodiment of the present invention will be explained

25   in detail below. FIG.3 is a block diagram showing the configuration of a mobile communication system according to an embodiment of the present invention.

The mobile communication system shown in FIG.3 is

constructed of a mobile terminal apparatus 100, a radio base station apparatus 300, a radio network control apparatus 500 and a core network 600. The mobile terminal apparatus 100 and the radio base station apparatus 300

5   are connected by a wireless channel 200. Furthermore, the radio base station apparatus 300 and radio network control apparatus 500 are connected by a wired channel 400. Furthermore, since the wireless channel 200 carries out best effort type transmission, the transmission rate

10   varies with time.

The radio network control apparatus 500 transfers data input from the core network 600 to the radio base station apparatus 300 through the wired channel 400 at a transfer rate instructed from the radio base station

15   apparatus 300. The transferred data is received by a reception section 311 of the radio base station apparatus 300 and temporarily stored in a buffer 304. This temporarily stored data is input to a radio transmission section 301 according to scheduling determined by a

20   scheduling section 303 according to a channel condition of a downlink channel, subjected to predetermined radio processing at the radio transmission section 301 and then transmitted to the mobile terminal apparatus 100 through the wireless channel 200.

25   A data amount measuring section 305 measures an amount of data stored in the buffer 304. The amount of data measured is notified to a wait time measuring section 306 and a transmission rate calculation section 307.

The transmission rate calculation section 307 calculates an average transmission rate of data transmitted to the mobile terminal apparatus 100 by radio based on information from the scheduling section 303. The scheduling section 303 sends the transmission rate calculation section 307 a scheduling result, that is, information indicating what amount of data of which time slot (which time) has been actually sent to which mobile terminal apparatus or what amount of data could have been transmitted if the communication environment had been such that would always give a transmission opportunity. Thus, the transmission rate calculation section 307 can determine an actual average transmission rate or virtual average transmission rate for each mobile terminal apparatus. For example, when data having a total of 320 kbits for 10 sec has been actually transmitted to the mobile terminal apparatus 100, the actual average transmission rate is calculated to be 32 kbps. Furthermore, in the case where though only an opportunity of transmitting data having a total of 320 kbits for 10 sec has been actually given, data having a total of 3 Mbits could have been transmitted if an opportunity for always transmitting data for 10 sec had been given, the virtual average transmission rate is calculated to be 300 kbps. The transmission rate calculation section 307 calculates either the actual average transmission rate or virtual average transmission rate according to the amount of data measured by the data amount measuring

section 305.   That is, when the amount of data measured
by the data amount measuring section 305 is equal to or
greater than a threshold, the actual average transmission
rate is calculated and when the amount of data measured
5   by the data amount measuring section 305 is less than
the threshold, the virtual average transmission rate is
calculated.   Thus, the method of calculating an average
transmission rate is changed based on the amount of data
stored in the buffer 304 and the radio base station
10   apparatus 300 can thereby instruct the radio network
control apparatus 500 on an optimal transfer rate even
when burst-like traffic occurs.   Moreover, the average
transmission rate calculated in this way is notified to
the wait time measuring section 306 and transfer rate
15   determining section 308.

        When there is substantially no possibility that
burst-like traffic may occur, instead of changing the
method of calculating the average transmission rate as
described above, it is also possible to use either the
20   actual average transmission rate or virtual average
transmission rate in a fixed manner.

        The wait time measuring section 306 measures the
data wait time in the buffer 304.   The wait time measuring
section 306 measures the data wait time in the buffer
25   304 from the amount of data measured by the data amount
measuring section 305 and the transmission rate
calculated by the transmission rate calculation section
307 according to following Expression (1):

Wait time = data amount in buffer 304/average
transmission rate ⋯ (1)

That is, the wait time measuring section 306 regards
a value obtained by dividing the amount of data measured
by the data amount measuring section 305 by the average
transmission rate calculated by the transmission rate
calculation section 307 as a data wait time in the buffer
304. Calculating the wait time in this way also makes
it possible to predict a future wait time and consequently
perform appropriate flow control. The wait time measured
in this way is notified to the transfer rate determining
section 308.

The transfer rate determining section 308
determines a transfer rate of data transferred from the
radio network control apparatus 500 to the radio base
station apparatus 300 from the average transmission rate
calculated by the transmission rate calculation section
307 and the wait time measured by the wait time measuring
section 306 according to following Expression (2):

Transfer rate = average transmission rate $\times \alpha$ ⋯ (2)

Here, coefficient α in Expression (2) above is a
coefficient determined according to the wait time, varies
between 0 and 1 and decreases as the wait time increases.
For example, the transfer rate determining section 308
has a table shown in FIG.4 and calculates a coefficient
α according to the wait time. In the example of FIG.4,
$\alpha = 1$ when the wait time is 0 to 100 ms, $\alpha = 0.7$ when the
wait time is 100 ms to 200 ms, $\alpha = 0.5$ when the wait time

is 200 ms to 300 ms, α =0.3 when the wait time is 300 ms

to 400 ms and α =0 when the wait time is 500 ms or above.

Thus, from Expression (2) above, the transfer rate

decreases as the wait time increases and the transfer

5 rate becomes 0 when the wait time is 500 ms or above.

That is, when the wait time is 500 ms or above, a data

transfer from the radio network control apparatus 500

to the radio base station apparatus 300 is stopped. In

this way, the transfer rate determining section 308

10 determines a value obtained by multiplying the average

transmission rate by a coefficient α which corresponds

to the wait time as a transfer rate. The transfer rate

determined is notified to the transfer parameter

determining section 309.

15   The transfer parameter determining section 309

determines credits (amount of data to be transferred in

a first data transfer process), interval (intervals at

which a data transfer process is performed) and repetition

period (count of repeating a data transfer process) of

20 transfer parameters so as to reach the transfer rate

notified from the transfer rate determining section 308.

The transfer parameters determined in this way are sent

from a transmission section 312 to the radio network

control apparatus 500 through the wired channel 400.

25   Here, the wait time can also be measured from the

configuration shown in FIG.5. That is, the radio base

station apparatus 300 has a TS (time stamp) adding section

313 and when data is input to the buffer 304, a time stamp

which is time information is added to the data by the
TS adding section 313. When the data with a time stamp
is output from the buffer 304, the wait time measuring
section 306 measures a difference between the time

5   indicated by the time stamp and the time at which the
data is output from the buffer 304 as a wait time. By
measuring the wait time in this way, it is possible to
measure the exact wait time with respect to the current
time point and consequently realize accurate flow

10   control.

        The transmission section 312 and reception section
311 exist in an FP (Frame Protocol) processing section
310 of the radio base station apparatus 300 and carry
out transmission/reception based on an HS-DSCH FP (High

15   Speed Downlink Shared Channel Frame Protocol).
Furthermore, the scheduling section 303, buffer 304, data
amount measuring section 305, wait time measuring section
306, transmission rate calculation section 307, transfer
rate determining section 308, transfer parameter

20   determining section 309 and TS adding section 313 exist
in a MAC-hs (Medium Access Control used for high speed)
processing section 302 of the radio base station apparatus
300.

        Next, the configuration of the radio network control

25   apparatus 500 will be explained. FIG.6 is a block diagram
of the radio network control apparatus according to an
embodiment of the present invention. An FP (Frame
Protocol) processing section 501 receives a transfer

parameter sent from the radio base station apparatus 300 based on an HS-DSCH FP (High Speed Downlink Shared Channel Frame Protocol). Then, the FP processing section 501 transfers the data to the radio base station apparatus 300 according to the transfer parameter. That is, the FP processing section 501 transfers data at a transfer rate determined by the radio base station apparatus 300. Furthermore, the FP processing section 501 sends the received transfer parameter to an RLC (Radio Link Control) processing section 503 so as to match the transfer rate for the data to be transferred to the radio base station apparatus 300 to the rate of the data output from the RLC processing section 503. That is, the FP processing section 501 also notifies the RLC processing section 503 of the transfer rate determined by the radio base station apparatus 300.

Here, the FP processing section 501 may notify the transfer rate to the RLC processing section 503 directly or through an MAC-d processing section 502. The RLC processing section 503 has the function of carrying out retransmission control on data based on a selective retransmission type retransmission control protocol and controls the rate of the data output to the MAC-d processing section 502 to the transfer rate notified from the FP processing section 501.

The MAC-d (Medium Access Control used for dedicated) processing section 502 carries out MAC-d processing on data input from the RLC processing section 503 and inputs

the data to the FP processing section 501. Matching the transfer rate of the data transferred to the radio base station apparatus 300 to the rate of the data output from the RLC processing section 503 prevents the wait time

5   of data in the buffer of the FP processing section 501 from further occurring. This further suppresses a transmission delay from the radio network control apparatus 500 to the mobile terminal apparatus 100.

An RLC process of the selective retransmission type

10   retransmission control protocol carried out by the RLC processing section 503 selects and retransmits NACK and notified data from among the transmitted data based on an ACK or NACK (Negative ACKnowledgement: negative response) notified from the mobile terminal apparatus

15   100. Furthermore, a MAC-d process carried out by the MAC-d processing section 502 adds a MAC-d header to the data input from the RLC processing section 503 and sends the data to the FP processing section 501. Details of the RLC process and MAC-d process are described in the

20   3GPP, TS25.321 Medium Access Control (MAC) protocol specification, V3.14.0.

Next, an operation sequence will be explained using FIG.7.

First, the radio base station apparatus 300

25   determines transfer parameter 1 which permits a data transfer and sends it to the radio network control apparatus 500.

The radio network control apparatus 500 which has

received this transfer parameter 1 starts a data transfer according to the instruction of the received transfer parameter 1. Data 0 to 10 transferred from the radio network control apparatus 500 are stored in the buffer

5   304 of the radio base station apparatus 300. Then, according to the scheduling at the scheduling section 303, the data stored in the buffer 304 are sequentially transmitted to the mobile terminal apparatus 100.

At this time, suppose that data 0 is discarded due

10   to a transmission error in the wireless channel 200. When the mobile terminal apparatus 100 receives next data 1, it detects from the discontinuity of the sequence number that data 0 has been discarded. As the notification of the reception condition, the mobile terminal apparatus

15   100 sends a request for retransmission of data 0 (retransmission request 0) to the radio network control apparatus 500. At the same time, the mobile terminal apparatus 100 starts a timer for controlling intervals at which the reception condition is notified. When the

20   radio network control apparatus 500 receives retransmission request 0, it retransmits data 0 at a transfer rate instructed by transfer parameter 2. Every time a predetermined time elapses after the transmission of transfer parameter 1, transfer parameter 2 and transfer

25   parameter 3 for instructing the transfer rate determined as described above are sent from the radio base station apparatus 300 to the radio network control apparatus 500.

The retransmitted data 0 is stored in the buffer

304 of the radio base station apparatus 300. Here, the radio base station apparatus 300 determines the transfer rate as shown above, suppresses the wait time in the buffer 304 to a level smaller than the intervals of notification

5   of the reception condition from the mobile terminal apparatus 100 (time from the start to end of the timer of the mobile terminal apparatus 100), and therefore the retransmitted data 0 is output from the buffer 304 within a time smaller than the intervals of notification of the

10   reception condition and sent to the mobile terminal apparatus 100. As a result, it is possible to suppress the wait time of data 0 in the buffer 304 to a small level as shown in FIG.7.

     When the timer times out, the mobile terminal

15   apparatus 100 which has received data 0 notifies the radio network control apparatus 500 that all data up to data 11 including the retransmitted data 0 have been received correctly.

     Then, the radio network control apparatus 500 which

20   has received the notification of normal reception transfers data 12 and subsequent data at the transfer rate instructed by transfer parameter 3.

     Thus, this embodiment takes into consideration both the average transmission rate from the radio base station

25   apparatus to the mobile terminal apparatus and the wait time in the buffer of the radio base station apparatus, determines the transfer rate from the radio network control apparatus to the radio base station apparatus,

matches the transfer rate to the rate of the data output from the RLC processing section of the radio network control apparatus, and can thereby prevent the radio network control apparatus from transferring an excessive
5   amount of data to a lower layer.

Furthermore, this embodiment reduces the time required for retransmitted data to arrive at the mobile terminal apparatus even when data retransmission occurs, and can consequently prevent all data stored in the radio
10 network control apparatus and mobile terminal apparatus from being discarded and prevent the wireless channel used by the mobile terminal apparatus from being disconnected.

When a threshold is set for a data amount in the
15 buffer 304 of the radio base station apparatus 300 and the amount of data stored in the buffer 304 exceeds the threshold, it is also possible to set the transfer rate to 0 and thereby stop a data transfer to the radio network control apparatus 500 and on the contrary when the amount
20 of data stored in the buffer 304 is smaller than the threshold, it is possible to carry out flow control using the above described transfer rate determining method. By so doing, it is possible to reliably prevent data transferred from the radio network control apparatus 500
25 from overflowing the buffer 304.

As described above, the present invention can reduce a wait time in a buffer in a communication system in which best effort type transmission is carried out between a

radio base station apparatus and mobile terminal apparatus through a wireless channel.

This application is based on the Japanese Patent
5   Application No. 2003-96746 filed on March 31, 2003, entire content of which is expressly incorporated by reference herein.

Industrial Applicability
10   The present invention is suitable for use in a radio base station apparatus, etc., in a mobile communication system.